that causes a signal to be sent to the brain. For example, in the case of a patient that has lost the use of limb, the affected limb is moved and/or stimulated while the brain is scanned using a known imaging technique that can detect neural activity (*e.g.*, functional MRI, positron emission tomography, etc.). In one specific embodiment, the affected limb can be moved by a practitioner or the patient, stimulated by sensory tests (*e.g.*, pricking), or subject to peripheral electrical stimulation. The movement/stimulation of the affected limb produces a peripheral neural signal from the limb that is expected to generate a response neural activity in the brain. The location in the brain where this response neural activity is present can be identified using the imaging technique. Figure 4, for example, can be created by moving the affected fingers and then noting where neural activity occurs in response to the peripheral stimulus. By peripherally generating the intended neural activity, this embodiment may accurately identify where the brain has recruited matter (*i.e.*, sites 220 and 230) to perform the intended neural activity associated with the neural-function.

An alternative embodiment of the diagnostic procedure 102 involves identifying a stimulation site at a second location of the brain where the neural activity has changed in response to a change in the neural-function of the patient. This embodiment of the method does not necessarily require that the intended neural activity be generated by peripherally actuating or stimulating a body part. For example, the brain can be scanned for neural activity associated with the impaired neural-function as a patient regains use of an affected limb or learns a task over a period of time. This embodiment, however, can also include peripherally generating the intended neural activity remotely from the brain explained above.

In still another embodiment, the diagnostic procedure 102 involves identifying a stimulation site at a location of the brain where the intended neural activity is developing to perform the neural-function. This embodiment is similar to the other embodiments of the diagnostic procedure 102, but it can be used to identify a stimulation site at (a) the normal region of the brain where the intended neural activity is expected to occur according to the functional organization of the brain and/or (b) a different region where the neural activity occurs because the brain is recruiting

additional matter to perform the neural-function. This particular embodiment of the method involves monitoring neural activity at one or more locations where the neural activity occurs in response to the particular neural-function of interest. For example, to enhance the ability to learn a particular task (*e.g.*, playing a musical instrument, memorizing, etc.), the neural activity can be monitored while a person performs the task or thinks about performing the task. The stimulation sites can be defined by the areas of the brain where the neural activity has the highest intensity, the greatest increases, and/or other parameters that indicate areas of the brain that are being used to perform the particular task.

Figures 5A and 5B are schematic illustrations of the implanting procedure 104 described above with reference to Figure 1C for positioning the first and second electrodes relative to a portion of the brain of a patient 500. Referring to Figure 5A, a stimulation site 502 is identified in accordance with an embodiment of the diagnostic procedure 102. In one embodiment, a skull section 504 is removed from the patient 500 adjacent to the stimulation site 502. The skull section 504 can be removed by boring a hole in the skull in a manner known in the art, or a much smaller hole can be formed in the skull using drilling techniques that are also known in the art. In general, the hole can be 0.2-4.0 cm in diameter. Referring to Figure 5B, an implantable stimulation apparatus 510 having first and second electrodes 520 can be implanted in the patient 500. Suitable techniques associated with the implantation procedure are known to practitioners skilled in the art. After the stimulation apparatus 510 has been implanted in the patient 500, a pulse system generates electrical pulses that are transmitted to the stimulation site 502 by the first and second electrodes 520. Stimulation apparatus suitable for carrying out the foregoing embodiments of methods in accordance with the invention are described in more detail below with reference to the Figures 6-40.

Several embodiments of methods for enhancing neural activity in accordance with the invention are expected to provide lasting results that promote the desired neural-function. Before the present invention, electrical and magnetic stimulation techniques typically stimulated the normal locations of the brain where

neural activity related to the neural-functions occurred according to the functional organization of the brain. Such conventional techniques, however, may not be effective because the neurons in the "normal locations" of the brain may not be capable of carrying out the neural activity because of brain damage, disease, disorder, and/or because of variations of the location specific to individual patients. Several embodiments of methods for enhancing neural activity in accordance with the invention overcome this drawback by identifying a stimulation site based on neuroplastic activity that appears to be related to the neural-function. By first identifying a location in the brain that is being recruited to perform the neural activity, it is expected that therapies (e.g., electrical, magnetic, genetic, biologic, and/or pharmaceutical) applied to this location will be more effective than conventional techniques. This is because the location that the brain is recruiting for the neural activity may not be the "normal location" where the neuro activity would normally occur according to the functional organization of the brain. Therefore, several embodiments of methods for enhancing neural activity in accordance with the invention are expected to provide lasting results because the therapies are applied to the portion of the brain where neural activity for carrying out the neural-function actually occurs in the particular patient.

2. Electrically Inducing Desired Neural activity

The method 100 for effectuating a neural-function can also be used to induce neural activity in a region of the brain where such neural activity is not present. As opposed to the embodiments of the method 100 described above for enhancing existing neural activity, the embodiments of the method 100 for inducing neural activity initiate the neural activity at a stimulation site where it is estimated that neuroplasticity will occur. In this particular situation, an image of the brain seeking to locate where neuroplasticity is occurring may be similar to Figure 3. An aspect of inducing neural activity, therefore, is to develop a procedure to determine where neuroplasticity is likely to occur.